Are time and space eternal?

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Space and time constitute a single four-dimensional space-time continuum. They are not separated, it is we who share them in our consciousness. And if we start moving at about the speed of light, then we will see that both time and space will begin to change, in accordance with Einstein's STR.

"...In accordance with the theory of relativity, the Universe has three spatial dimensions and one temporal dimension, and all four dimensions are organically linked into a single whole, being almost equal and within certain limits... capable of passing into each other when the observer changes the frame of reference...

Within the framework of the general theory of relativity, space-time also has a single dynamic nature, and its interaction with all other physical objects (bodies, fields) is gravity. Thus, the theory of gravity within the framework of general relativity... is the theory of space-time, which is assumed not to be flat, but capable of dynamically changing its curvature.

Until the beginning of the twentieth century, time was assumed to be independent of the state of motion, flowing at a constant speed in all reference frames; however, then experiments showed that time slows down at high speeds of one frame of reference relative to another. This slowing down, called relativistic time dilation, is explained in the special theory of relativity.

The slowing down of time has been confirmed by many experiments, such as the relativistic slowing down of muon decay in a stream of cosmic rays and the slowing down of atomic clocks on board a space shuttle, rocket and airplanes, relative to the clock installed on Earth. The length of time, therefore, may vary depending on events and frame of reference..." [1].

Moreover, the space-time continuum cannot exist without matter (according to general relativity), and matter cannot exist without space-time. Therefore, this question (Are time and space eternal?), qoes into another form:

Are matter and energy eternal?

In our Universe, according to Noether's theorem, taking into account our space-time continuum, namely, the homogeneity of time and space, the law of conservation of energy-momentum operates [2]. In fact, this law is a consequence of the existence of space-time. In the theory of relativity, time and space can change, and therefore, the law of conservation of energy-momentum can only be applied locally. For further reasoning, let's conduct a thought experiment.

We are on planet Earth, in our Solar System, in our Milky Way galaxy. Let's say we have the ability to move our galaxy throughout the Universe, to any point in the infinitely large Universe. Naturally, it is necessary to

move a galaxy to explore space-time to places where, in the vicinity, there are no black holes, other galaxies and other massive objects that, due to gravity, will change the space-time characteristics. Question:

in different places of the Universe, will we find that the space-time continuum will be different or still the same?

It is quite obvious that we will inevitably fix the homogeneity of space and time throughout the entire Universe. This follows strictly from the cosmological principle.

"...The cosmological principle is the basic provision of modern cosmology, according to which each observer at the same time, regardless of the place and direction of observation, discovers the same picture in the Universe on average. Independence from the place of observation, that is, the equality of all points in space, is called homogeneity; independence from the direction of observation, that is, the absence of a distinguished direction in space - isotropy..." [3].

Moreover, the cosmological principle will guarantee the homogeneity of space and time strictly, precisely on large scales (hundreds and billions of light years). This is what we need, since we are analyzing the properties of space and time of the whole Universe.

Consequently, in the Universe, space and time are homogeneous, which means that the law of conservation of energy-momentum can still be applied to the Universe as a whole. That is, matter in the Universe exists eternally, and existed initially, like the space-time continuum, and therefore, it is an indestructible and uncreable substance, which expresses the corresponding conservation law.

1. Spacetime. Wikipedia. https://en.wikipedia.org/wiki/Spacetime
2. Noether's theorem. Wikipedia. https://en.wikipedia.org/wiki/Noether%27s_theorem
3. Cosmological principle. Wikipedia. https://en.wikipedia.org/wiki/Cosmological_principle

P.S. Here you can read more about some aspects of time and space:

1. Quantization of space-time and Zeno's aporia. http://dx.doi.org/10.13140/RG.2.2.34726.04163

2. How many dimensions is space? http://dx.doi.org/10.13140/RG.2.2.28812.64645

3. Equivalence of space and time. http://dx.doi.org/10.13140/RG.2.2.10932.78727

4. Elementary particles and time. http://dx.doi.org/10.13140/RG.2.2.35543.19367